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Walking the Line: Finding Balance Between Commodity and Custom Intelligent Completion Systems

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Abstract

For most of the ten years since market introduction, the majority of intelligent completion systems have been custom-designed and manufactured to meet the specific requirements of the customer. Customization was a natural step in the evolution of the technology, as operators tested usability and reliability in individual wells that reflected unique environments and challenges. Each situation was different, and the technology developed more or less in answer to those distinct demands (Figure 1); consequently, the experience base grew and the capabilities expanded.

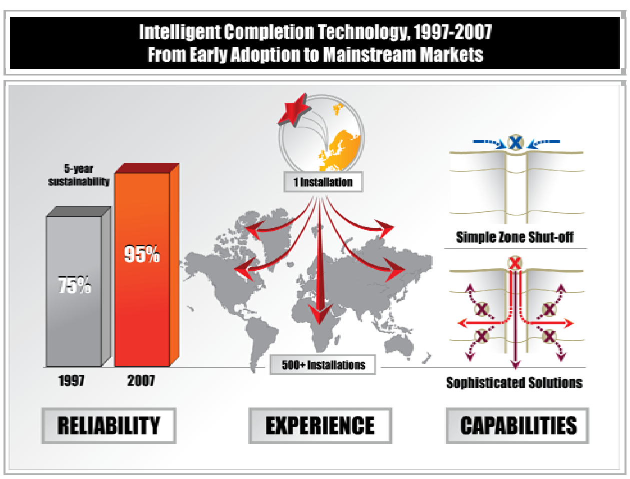

Figure 1

As intelligent completion technology has "crossed the chasm"[1] from the early adopter stage to mainstream market acceptance – growing from its early usage almost entirely for intervention avoidance to its current use as a primary component in optimizing production – demands for customization have kept pace (Figure 2). Customers are looking today for the best well solutions available – not just the latest technology. Meeting this demand often means providing more holistic solutions, usually with some degree of customization factored in, and generally at the most cost-effective rate.

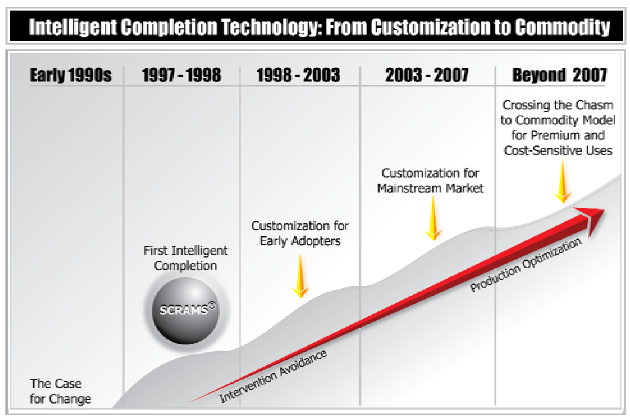

Figure 2

But an interesting, and perhaps game-changing, trend has developed in parallel. Like users of most popular technologies, operators are now demanding that intelligent completion systems be designed more rapidly, manufactured more cheaply, and delivered sooner – all at lower prices. To these users, the technology has evolved from a costly customized solution to a commodity that can be cost-effectively and rapidly produced and delivered.

This emerging theme of dual manufacturing models – one for customization, one for commodity – leaves suppliers of intelligent completion technology with a puzzle: how to satisfy a market that demands customization at a commodity price, while still delivering high-quality, innovative products that can support the industry in the future.

This paper contemplates how such a balance might be struck, offering an examination of the following:

- **The discrepancies between the demands of the market and the operational limits of suppliers**. Could oilfield operators implement subtle changes in their practices that lessen the impact of customization and/or commoditization on technology suppliers? When does the tradeoff between meeting market demand and developing innovative technologies become unsustainable by providers?

- **The appropriate levels at which a lower-price commodity model may actually drive better manufacturing processes**. Could today's low-end intelligent completions systems, given more rapid and reliable operations, become effective tools in mid-range and premium markets? Would minor levels of customization make those products accepted more widespread?

- **An evergreen solution that can enhance bottom-line profits for both operators and suppliers**. At what point does cost-effective, quick manufacture impact quality? In what arenas are the likely improvements to be made? What happens if market demands suddenly shift?

Determining Discrepancies between Market Demands and Suppliers' Operational Limits

The more operators customize their completion programs, the greater the discrepancy between their specific demands and the operational limitations of the technology provider. Introduced into the mix are more complex designs, changes in manufacturing processes, added costs for products, and an increase in time-to-market.

To merge these differences closer together, could operators make subtle, or even dramatic, changes to material requirements, project design or quality standards?

Material Requirements: Can a Middle-Ground Be Found?

Is relaxing material requirements a potential way of limiting the discrepancies between market demands and the supplier's operational limits?

In the early 1990s, reacting to the failure of Inconel 718-based equipment in a subsea Gulf of Mexico project, one major operator began imposing strong restrictions against using Inconel 718 in the manufacture of its intelligent completion equipment. The alternative choice was the more expensive and more difficult-to-obtain Inconel 725 – or better.

While the *operator* was certainly within its rights to demand that higher-alloy materials be used in the manufacture of its equipment, a few things that would impact the *manufacturer* should have also been considered:

- Using Inconel 725 – when the equipment had already been tested with Inconel 718 – impacted both the design and application of the technology

- Additional testing of the Inconel 725-based equipment led to higher costs to the manufacturer, and extended the time-to-market period

- The additional costs and time incurred by the manufacturer resulted in high equipment prices and longer delivery times

In this case, had the manufacturer been able to use its tested Inconel 718-based stock items, higher costs and longer lead times could have been avoided.

Optimized Project Design: Is Research an Answer?

Would better research into well and total system conditions offer a way to limit the discrepancies between market demands and the supplier's operational limits?

In injection wells, high chrome alloys are often used to mitigate corrosion and, in some cases, erosion. A possible solution is to modify surface injection facilities to decrease solids content and remove oxygen. One operator had sufficient confidence in its optimized surface injection design to use lower-alloy 13Cr tubulars in a water injection application when the downhole equipment, at injection conditions, would not see free oxygen.

In another example, a major national oil company (NOC) applied research to gain a better understanding of well conditions and consequently to reduce its costs. The research also revealed more information about the limits of lower-alloy materials in the company's applications. Researchers found that carbon steel and lower-alloy stainless steels could be used successfully in scenarios where high nickel and chrome alloys were normally thought to be required.

Quality Standardization: What Is the Price?

Arduous quality requirements are often imposed as a method of risk mitigation for possible manufacturing and testing defects – but at what price? Various operating companies require company-specific – and often asset-specific – quality requirements. Implemented by different personnel in different regions, these conflicting requirements can create confusion and undue burden on a manufacturing facility.

A number of operating companies are working on global quality requirement standards, with the objective of improving internal efficiency and ensuring a uniform result, regardless of end use location. The same quality constraints – non-destructive testing (NDT) during component manufacture, assembly testing, documentation review, to name a few – can be applied for multiple projects. This process allows for substitution of component parts within a single operator's equipment supply, thereby increasing the flexibility of manufacturing, driving down costs, and improving delivery times.

Certainly, a standard approach is an improvement – but it can be applied only to "high profile" projects. Is there a better model to drive quality manufacturing and still provide the best solutions to customers?

One potential direction to streamline the quality standardization process and reduce costs even further is creating accepted standards for some of the components of the intelligent completion. These types of standards already exist for packers, for example, through the "V" qualification standards. A Norwegian operator took ownership of working with the service sector to develop testing criteria to qualify interval control valves (ICVs) as barriers during well completion and workover. Finally, the supplier community has already developed standard specifications for testing product subcomponents such as seals used in actuators on ICVs and packing elements. Bringing some of these initiatives together to establish generic qualification standards could ultimately produce a finite understanding of requirements by suppliers, resulting in lower product costs through efficiencies gained.

Using a Lower-Price Commodity Model to Drive Better Manufacturing Processes

Unique to most sectors of the oilfield, the intelligent completion business developed from the top down – premium products in premium markets (offshore Norway, deepwater Gulf of Mexico), cascading down more recently to cost-effective products for land-based and shallow-water applications. This trend forced early focus on areas unique to high-end markets – extreme focus on reliability[2,3], HPHT, large-bore equipment, for example – with development driven by a few operating companies and internal technology departments within the service providers.

But as the intelligent completion market grows and becomes more widely accepted, new aspects of the intelligent completion market are being developed to accommodate mid-range and low end technologies.

A Case Study: Premium Packers vs Mid-Range Packers

As an example, let us consider the practical development of high-end feed-through production and injection packers, developed for the premium markets of high load and pressure differential. Specifications include the following:

9-5/8" 53.5# x 5-1/2" 23#

Five-line feed thru

530,000 lbs tension and compression

7,500 psi differential

In many intelligent completion applications, these packers are well in excess for well conditions – and they can cost twice what a moderate-range (5000 psi differential) packer made of similar metallurgy can cost.

Operators have consequently begun to demand more moderate and low-range products, leading to improved fit-for-purpose solutions. Some of these solutions include simplified retrievable packers (both isolation and injection), swell packer technology, and feed-through seal assemblies where appropriate. Applications in which fluid is "influenced" but not controlled are being considered without zone-by-zone isolation.

As these news applications have become more commercially available, operators have often scaled back from the premium solutions they used previously to the more cost-effective range. Two obvious examples of this trend are water injection wells in the Far East, in which premium tools have been replaced by lower specification equipment (though still appropriate for the application), and production wells in Oman, in which the premium flow control equipment has been replaced by cost-effective products and premium feed-through packers have been replaced by swell technology[4].

Equipment with these lower specifications has certain advantages over the highly-specialized premium products, not the least of which are the better cost effectiveness and more rapid delivery. Non-specialized quality requirements allow manufacturing companies to stock standard parts, design for repeatable manufacture, and fully optimize the manufacturing process.

Establishing an Evergreen Solution

Determining how to bring to market the best of both customized and commodity solutions in a competitive environment is a challenge for the technology provider (Figure 3). As the cost-effective market (less than 3000 BPD and 5000 psi reservoir pressure) becomes a more viable opportunity for intelligent completion technology[5], suppliers will face additional challenges: designing the right solution for the greatest number of opportunities, providing reliable solutions without a premium price tag, and adapting quickly to market changes and demands.

Although a "one-size-fits-all" solution does not exist in any aspect of the oilfield, much less in a new technology area such as intelligent completions, certain steps *can* be taken to improve efficiencies in both design and manufacturing; for example:

- A modular approach to completion design can assist in proving out these efficiencies
- Selecting the baseline criteria for design is critical
- Standardizing designs may eliminate the ability to provide solutions in specific markets, but it will attempt to capture the largest range of environments without excessive design change and modification

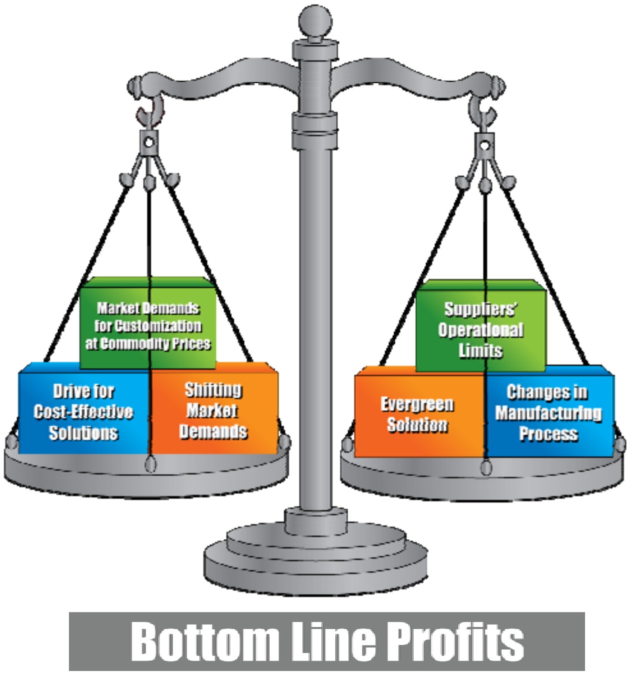

Figure 3

In premium markets, reliability is one of the first considerations of operators. But how does this requirement for better than 95% reliability at five years translate to the cost-effective markets? Being held to the same standard, designing for reliability is even more crucial as the funding does not exist to perform as extensive a test program as would be adopted for a premium product. The design is simplified over premium products, allowing for more efficient manufacturing and greater repeatability in assembly and installation.

Can customized products be sourced out of emerging countries such as China and India? The struggle on the manufacturing side in a technology market is the number of parts to be built is relatively low, but the cost advantages can still be tremendous.

Conclusions

As intelligent completion technology enters its second decade, a potentially game-changing trend could force suppliers of the technology to produce highly-customized systems using a cost-effective commodity model. Attempting to integrate these two disparate models could have a significant impact not only on the use of intelligent completion systems, but also on the suppliers who must simultaneously satisfy customer demand and deliver innovative technology.

Is it possible that operators and suppliers could relax some of their self-imposed constraints to produce new technologies at lower costs and speedier time to market? Could today's low-end systems gain better acceptance if they could be slightly customized to meet the requirements of mid-range and premium markets? Is there a future solution that could provide bottom line profits for both operators and suppliers?

The answers to these questions will drive the next decade of intelligent completion technology.

Acknowledgments

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References

1. Moore, Geoffrey, Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers, 1991.

2. Veneruso, A., Kohli, H., "Towards Truly Permanent Intelligent Completions: Lifelong System Survivability Through a Structured Reliability Assurance Process," SPE 84326, presented at the 2003 SPE Annual Technical Conference and Exhibition held in Denver, Colorado, 5-8 October 2003.

3. Mathieson, D., Roger, J., Rajagopalan, S., McManus, R., "Reliability Assurance, Managing the Growth of Intelligent Completion Technology," SPE 84327, presented at the 2003 SPE Annual Technical Conference and Exhibition held in Denver, Colorado, 5-8 October 2003.

4. V. Ogoke, SPE, Shell; C. Aihevba, SPE, Petroleum Development Oman; and F. Marketz, SPE, Shell, "Cost-Effective Life-Cycle Profile Control Completion System for Horizontal and Multilateral Wells, SPE 102077, presented at the 2006 SPE Annual Technical Conference and Exhibition held in San Antonio, Texas, 24-27 September 2006.

5. Petrich, B., Konopoczynski, M., Brnak, J., "Application of SmartWell® Technology to the SACROC CO_2 EOR Project: A Case Study," SPE 100117, presented at the 2006 SPE Annual Technical Conference and Exhibition held in San Antonio, Texas, 24-27 September 2007.

Figures